REAL-TIME PLUTONIUM, AMERICIUM, AND CURIUM MONITOR

TECHNOLOGY DESCRIPTION

This project has developed an on-line monitor that can measure in real time the concentrations of various metal oxides in a molten glass stream. It can be used to measure most transuranics in a vitrification process stream. The monitor uses the spontaneous thermal emission spectrum of the molten glass stream to measure the stream composition. It passively observes this spectrum through a fiber-optic cable, so the instrument can be mounted outside the radiation zone. It uses a charge-coupled-device-array-based spectrometer mounted on a personal computer expansion card, so the instrument as a whole is small and robust. The emission spectrum contains certain peaks that are characteristic of the individual transuranic metal oxides and whose heights indicate the concentrations of the metals. The baseline technology for vitrification monitoring requires sampling the glass, transporting the highly radioactive glass to the laboratory, performing a destructive analysis, most commonly using inductively coupled plasma techniques, and then storing or disposing of the sample. The project technology is safer, faster and cheaper because it provides an analysis in real time without contacting the radioactive glass stream.

TECHNOLOGY NEED

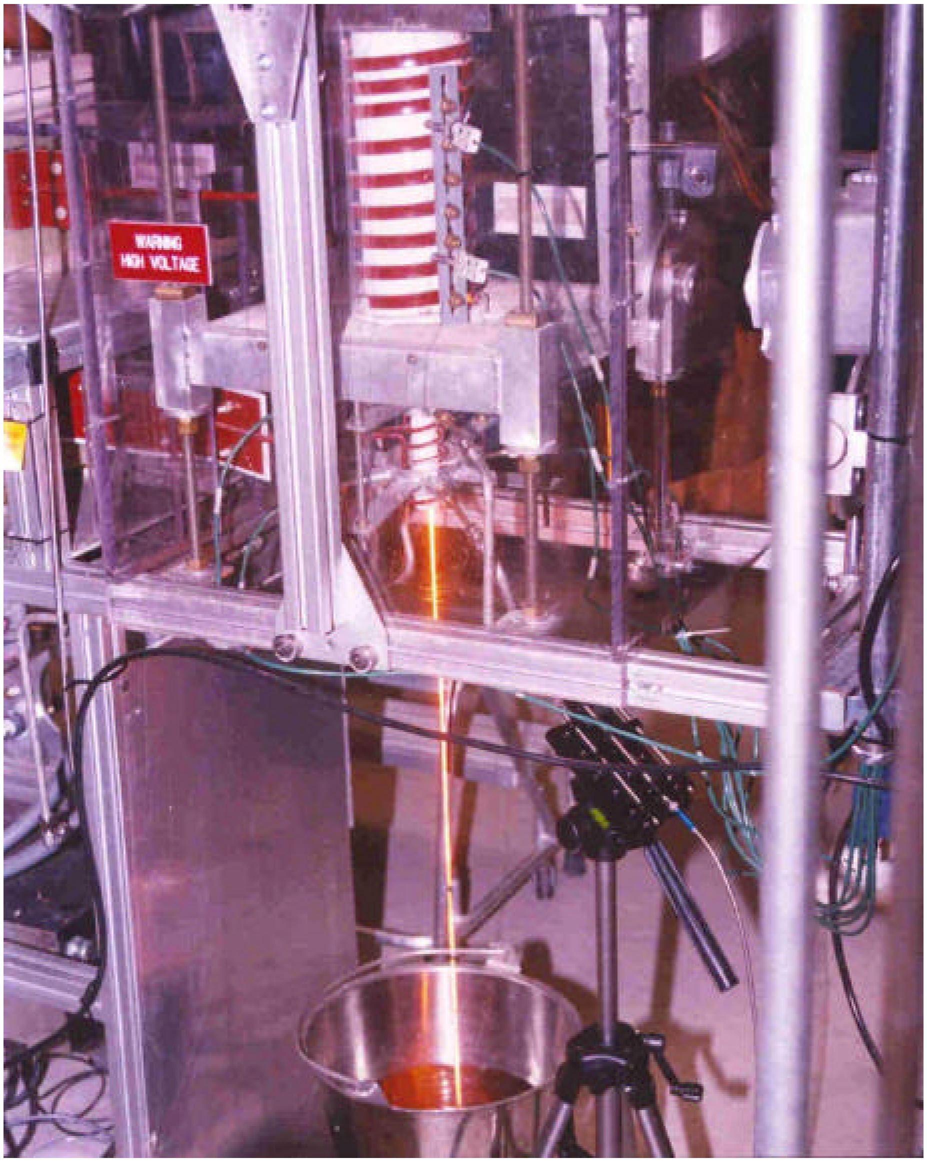
When DOE uses vitrification, it is often for processing wastes containing radionuclides whose presence must be quantitatively tracked. The project monitor can measure the amount of most transuranic metals, as well as many other metals, in a molten glass stream, so the monitor is potentially useful for many DOE vitrification processes. We have been working with the Americium-Curium Stabilization project at the Savannah River Site, so the device has been tailored to measure americium and curium to satisfy their Site Technology Coordination Group (STCG) Need SR99-5003 "Non-Destructive Assay (NDA) of Vitrified Americium/Curium." A monitor was delivered to them at the beginning of FY 2000, and it will be incorporated into the F Canyon vitrification system set to go on line in 2002.

TECHNOLOGY BENEFITS

The on-line monitor provides both cost and safety benefits while improving control of the vitrification process. It reduces the number of samples that must be taken and analyzed off line, thereby improving worker safety by reducing the handling of highly radioactive materials. Each sampling and off-line analysis is estimated to cost between $50,000 and $100,000 and to require about one week, and it will generate secondary waste. Once installed and calibrated, the on-line monitor will provide analyses automatically at negligible cost in less than one minute without contacting the radioactive material. The immediate information feedback provided by the monitor will alert the vitrification operators to problems or unexpected conditions so that they can be efficiently handled. The monitor record would also provide a more detailed archival record of the composition of the vitrified material than occasional sampling and analysis can.

TECHNOLOGY CAPABILITIES/LIMITATIONS

The thermal emission spectrometer can use near infrared spectroscopy to monitor in real time the concentrations of transuranics and many other metal oxides in molten glass streams or static pools up to about one-quarter-inch thick. The technology is potentially applicable to most vitrification processes. A light-gathering head within about 2 feet of the glass is connected by a fiber-optic cable to the rest of the instrument, so the monitor is largely unaffected by the radiation level of the glass. The monitor does depend on the transparency and high temperature of the molten glass, so it can not be used on thick (opaque) glass or on lower temperature (roughly under 1000 °C) glass.



The tripod-mounted light-collection head of the monitor (lower right) during a test of the monitor at the Savannah River Site. The rest of the monitor is many feet away, connected by a fiber-optic cable. The head is aimed up at the beginning of the glowing molten-glass stream that is pouring from the Cylindrical Induction Melter into a pail of water.

COLLABORATION/TECHNOLOGY TRANSFER

We have collaborated with the staff of the Americium-Curium Stabilization Project at Savannah River, tailoring the monitor technology and protocol to their needs. Start up of vitrification in their Canyon Facility is scheduled for 2002, and our monitor will be part of that facility. They have hosted on-site tests of our monitor on their developmental vitrification melter, as well as supplied test materials. We delivered a functional monitor system to them at the beginning of FY 2000, and have worked with them on training, operation, and safety. Thermal emission spectroscopy is a mature technology and its application to vitrification is a niche market, so no efforts toward commercialization have been made. A paper on the project results was given at Pittcon, the principal analytical-science conference in North America, in March, 1998. An Innovative Technology Summary Report is being prepared.

ACCOMPLISHMENTS AND ONGOING WORK

Three on-site tests of the on-line monitor have been conducted at Savannah River. The first test was in August 1997 with the staff of the Glass Formulation and Vitrification Process Development Task for the Plutonium Immobilization Program. The other tests were in July 1998 and October 1999 with the staff of the Americium-Curium Stabilization Project. The first of the three tests compared thermal emission spectroscopy (TES) and a variant of TES called transient infrared spectroscopy as monitoring methods. TES was found to be superior. The second and third tests applied an improved monitor to a melter system that was much closer to what will be used for actual vitrification at the Savannah River Site (SRS). The third test also constituted a training session on the monitor for the staff at SRS. All three tests showed successful quantitation of surrogates for transuranics in the molten glass. Parallel with these tests was work to convert the original, laboratory-style device to a field unit. The original monitor had an instrument box located very near the glass stream and required three supporting boxes of electronics along with a personal computer to control it all. This has now been condensed down to a small light-collection head within a foot or two of the stream that connects via a fiber-optic cable to an expansion board inside a personal computer. The rest of the electronics has been eliminated. A complete monitor system was delivered to SRS at the time of the third test. The formal project has now been completed. We are now assisting the SRS staff, on an *ad hoc* basis, in response to their requests.

TECHNICAL TASK PLAN/TECHNOLOGY MANAGEMENT SYSTEM INFORMATION

TTP No. /Title: CH17C232 - Real-Time Plutonium Monitor (also for Americium and Curium). The previous title for this TTP was: Real-Time Plutonium Monitoring by Transient Infrared Spectroscopy.
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